

Do we still need Airborne Wind Energy?

AWEC 2017
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The world in 2004...



Source: NASA

15 September 19, 2017

**Bloomberg
New Energy Finance**

The Problem: Renewable Energy Prices

Wind and solar costs

Wind



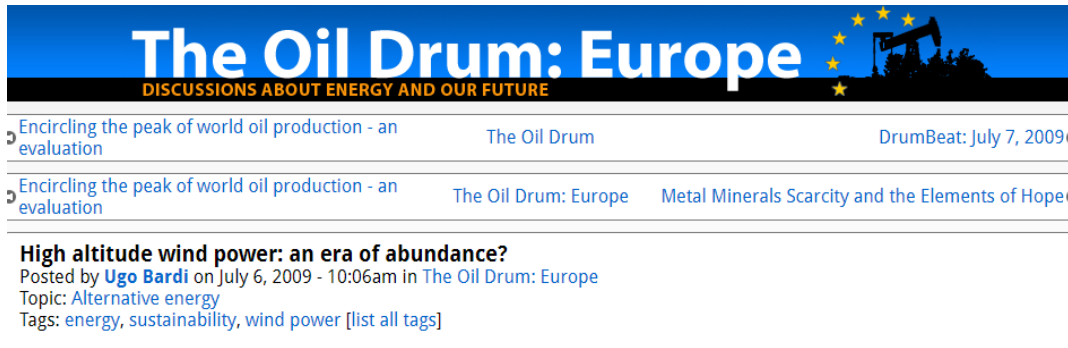
Source: Bloomberg New Energy Finance

Solar



Source: Bloomberg New Energy Finance

The Solution: Airborne Wind Energy



The screenshot shows the header of 'The Oil Drum: Europe' with the tagline 'DISCUSSIONS ABOUT ENERGY AND OUR FUTURE'. Below the header, there are two article listings. The first is 'Encircling the peak of world oil production - an evaluation' by 'The Oil Drum' dated 'DrumBeat: July 7, 2009'. The second is 'Encircling the peak of world oil production - an evaluation' by 'The Oil Drum: Europe' and 'Metal Minerals Scarcity and the Elements of Hope'. Below these is a highlighted article: 'High altitude wind power: an era of abundance?' posted by 'Ugo Bardi' on July 6, 2009. The topic is 'Alternative energy' and tags include 'energy, sustainability, wind power'.

- “Renewables are growing fast, but can they grow fast enough to compensate for the depletion of fossil fuels? **We have a problem of cost.**”

google.org

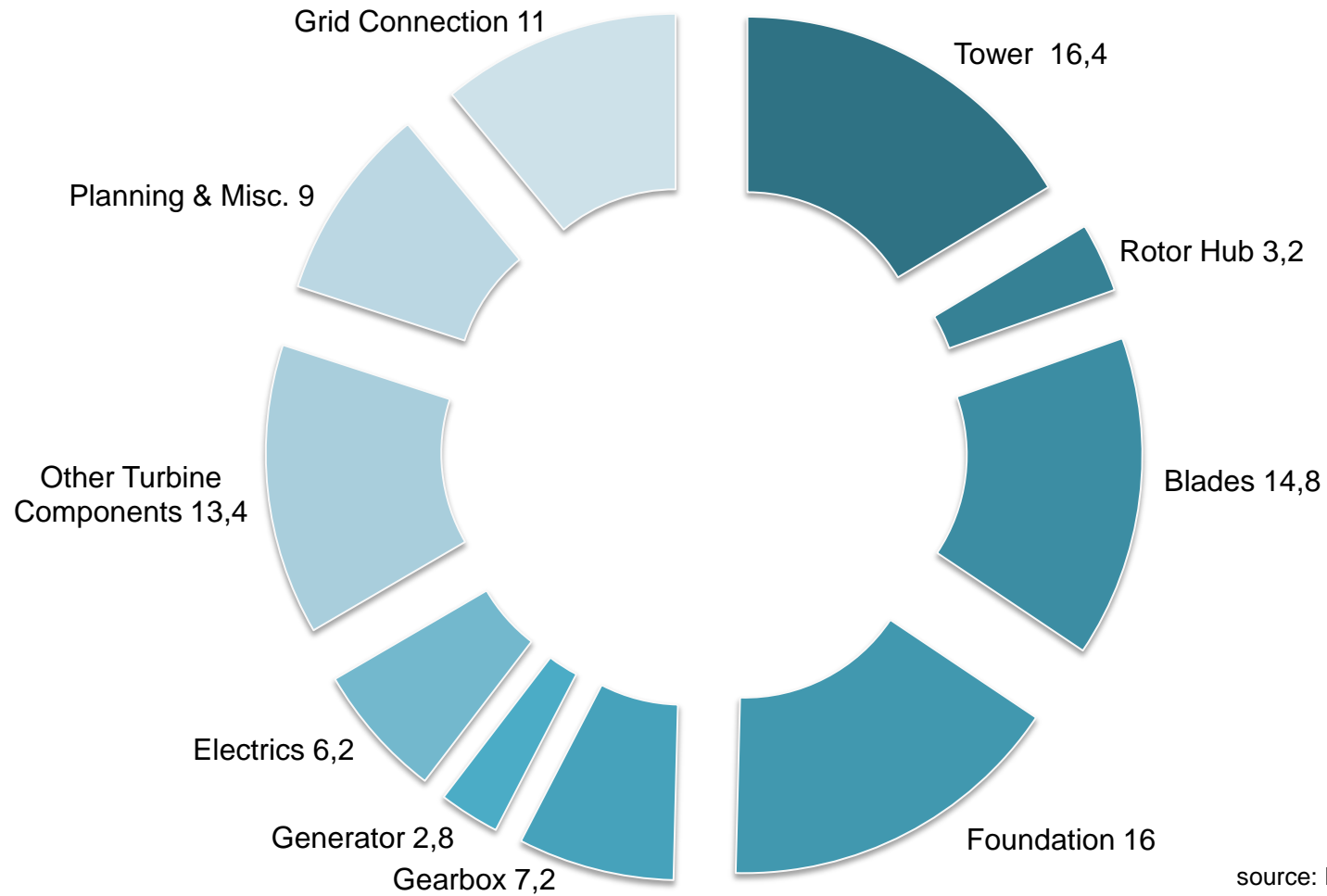
January 2008

Develop Renewable Energy Cheaper Than Coal (RE<C)

Introduction

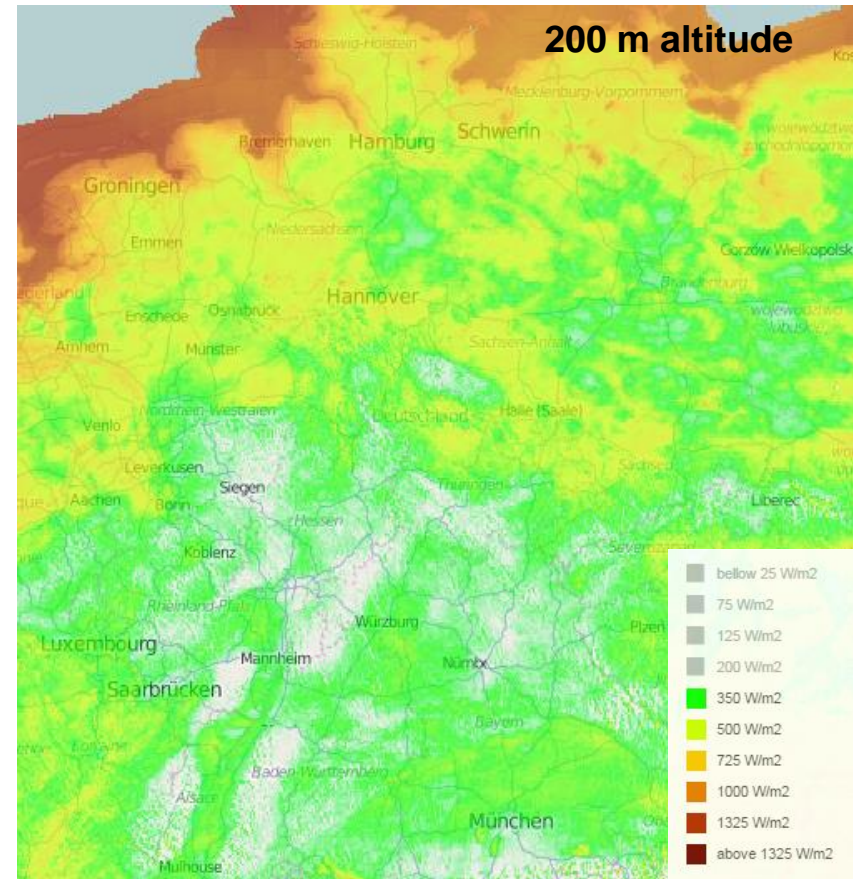
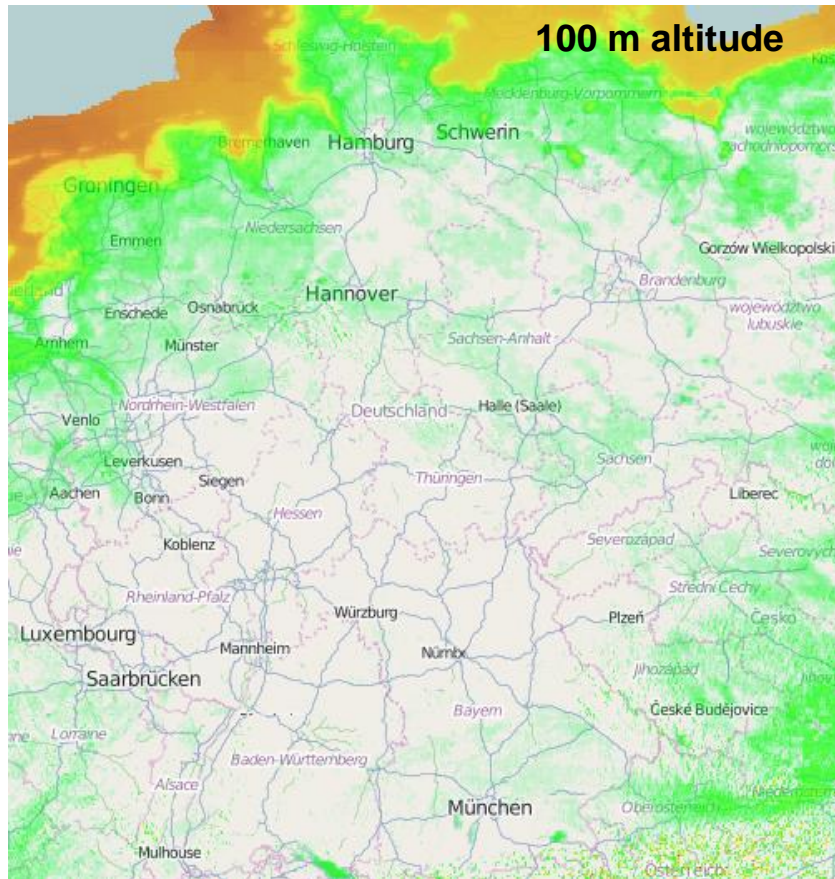
In the fall of 2007, Google launched an initiative called “Renewable Energy Cheaper than Coal” or

Lower Installation Costs



source: IRENA

Higher output due to High-Altitude Winds



IRENA: Global Atlas, Map data: DTU 2015, OpenStreetMap contributors



The world today...



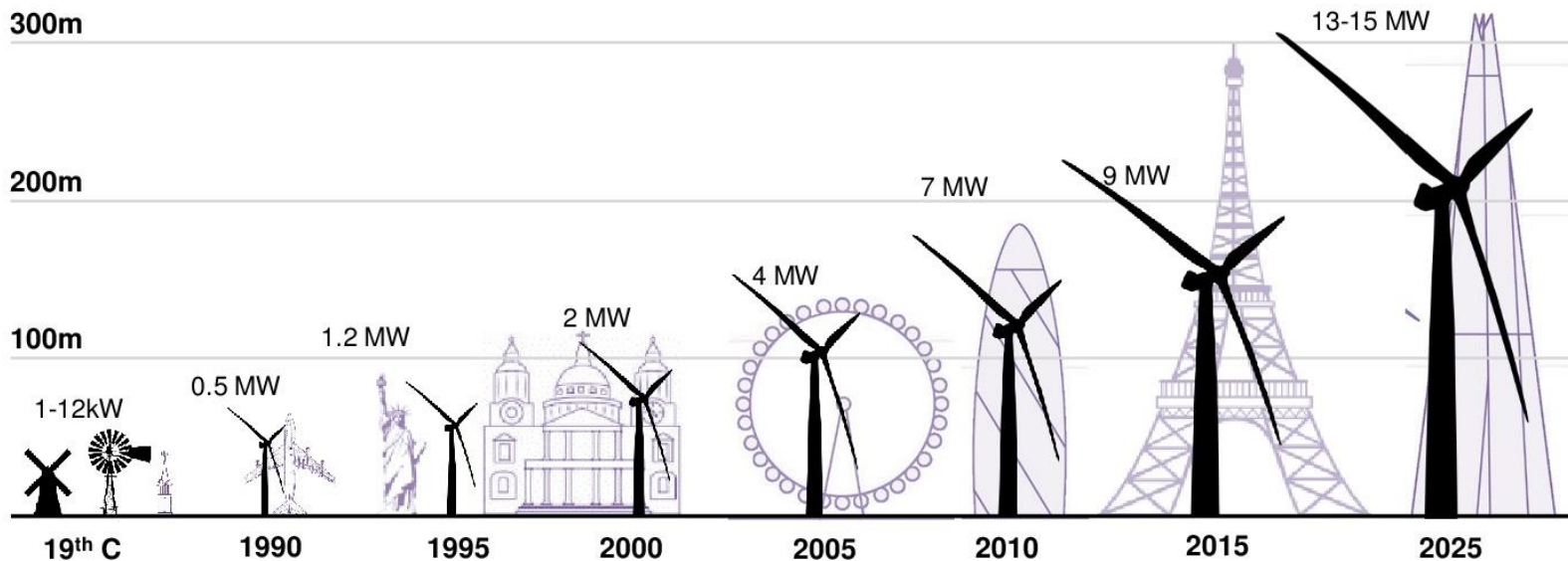
Image: NASA

35 September 19, 2017

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Wind Energy Growth

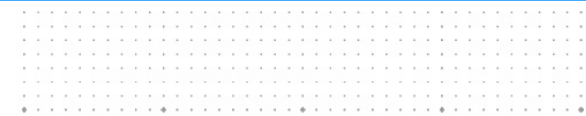
Evolution of wind turbine heights and output



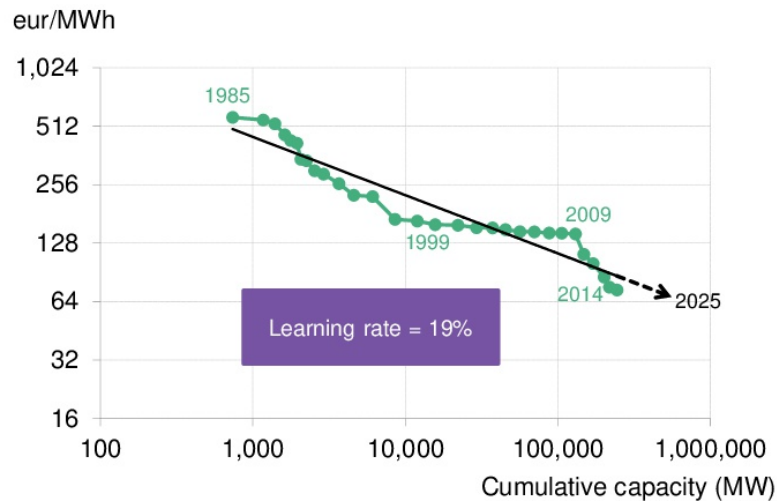
Sources: Various; Bloomberg New Energy Finance

Prices Fall Dramatically

Wind and solar experience curves

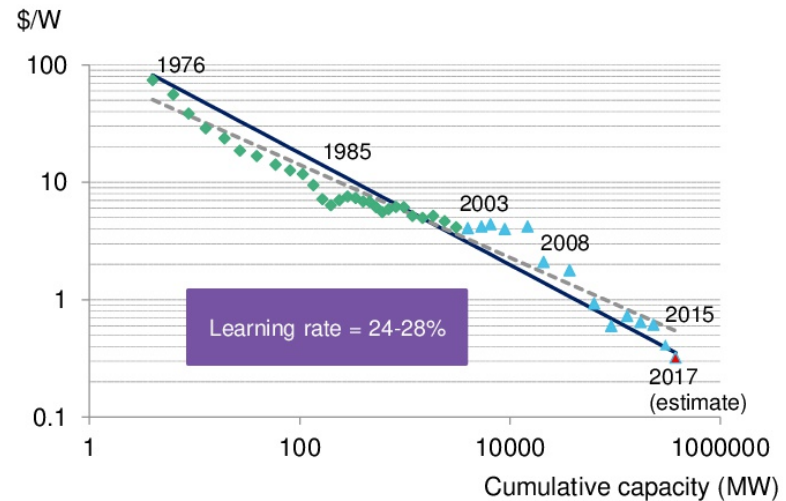


Wind



Source: Bloomberg New Energy Finance

Solar



Source: Bloomberg New Energy Finance

Renewable Energy Price Records 2017

Unsubsidised clean energy world records 2017



Solar PV



Country: United Arab Emirates
 Bidder: Marubeni and Jinko Solar
 Signed: 2017
 Construction: 2019
Price: US\$ 2.42 c/kWh

Onshore wind



Country: Morocco
 Bidder: Enel Green Power
 Signed: 2016
 Construction: 2018
Price: US\$ 3.0 c/kWh

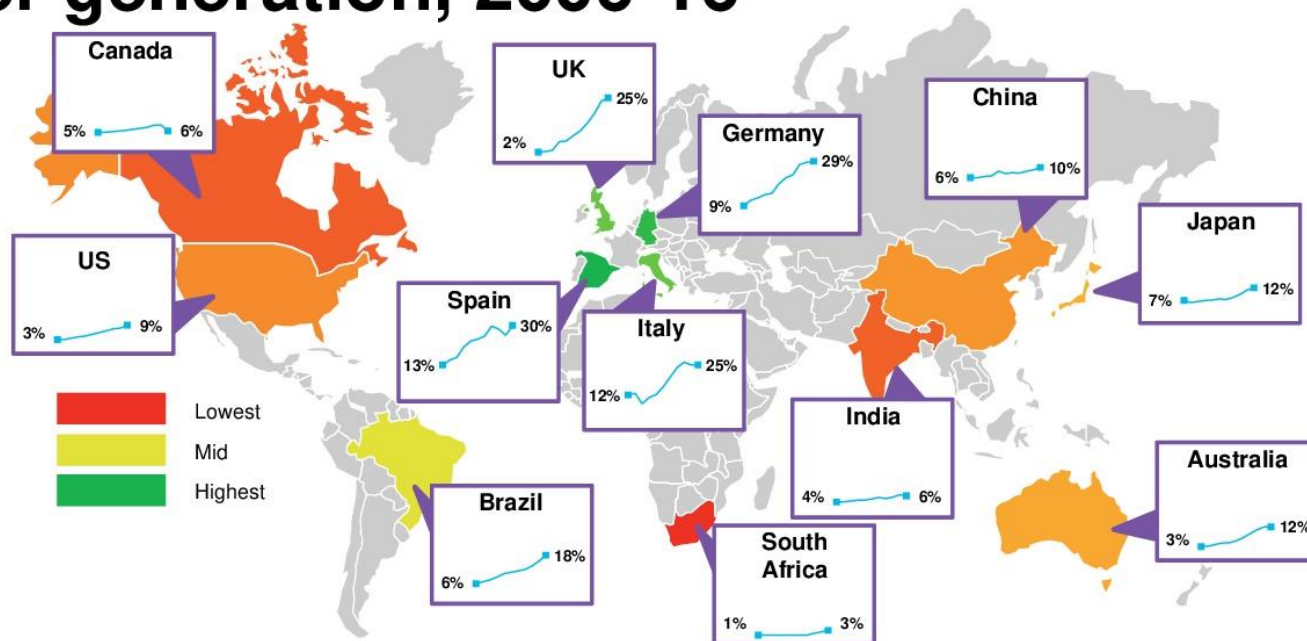
Offshore wind



Country: Germany
 Bidder: DONG/EnBW
 Signed: 2016
 Construction: 2024
Merchant Price: US\$ 4.9 c/kWh

Source: Bloomberg New Energy Finance; Images Siemens; Wikimedia Commons; Masdar

Renewable energy proportion of power generation, 2006-16



Note: Excludes large hydro Source: Bloomberg New Energy Finance

The world in 2040



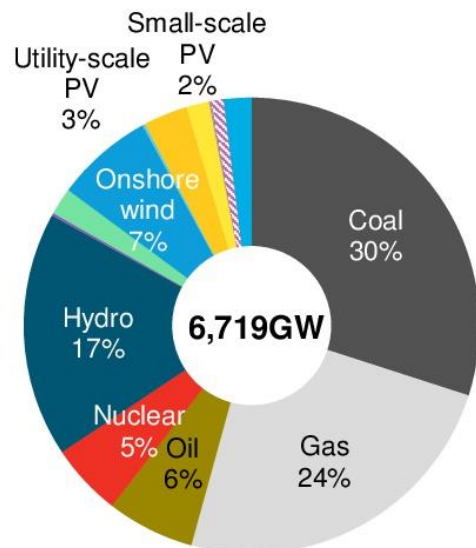
Image: NASA

89 September 19, 2017

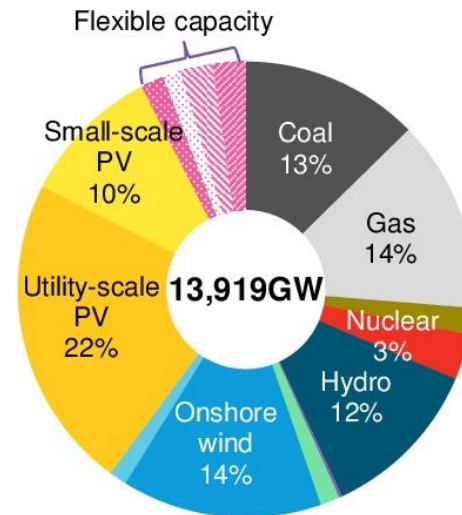
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Solar and wind dominate the future of electricity

Global cumulative installed capacity: 2016



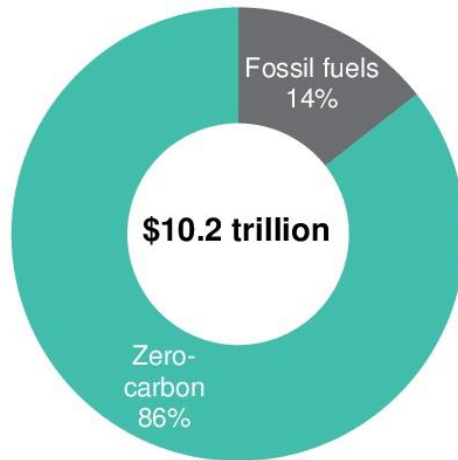
Global cumulative installed capacity: 2040



Source: Bloomberg New Energy Finance, *NEO 2017*

Solar and wind attract 60% of new investment in power generating capacity

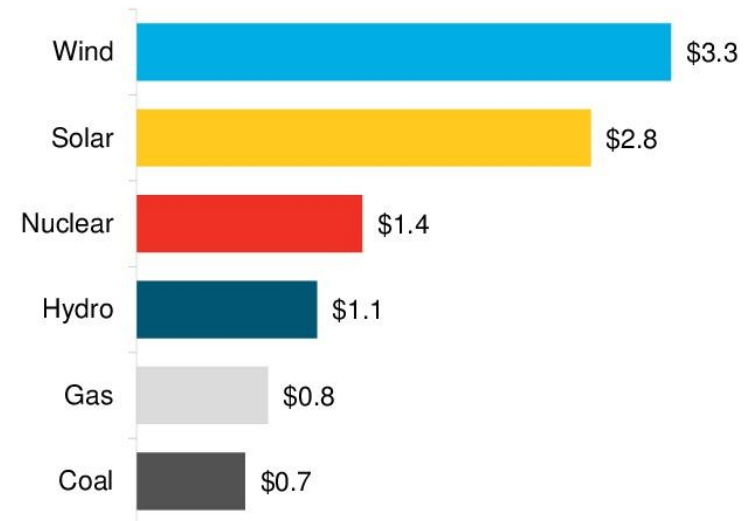
Investment, by technology, 2017-2040



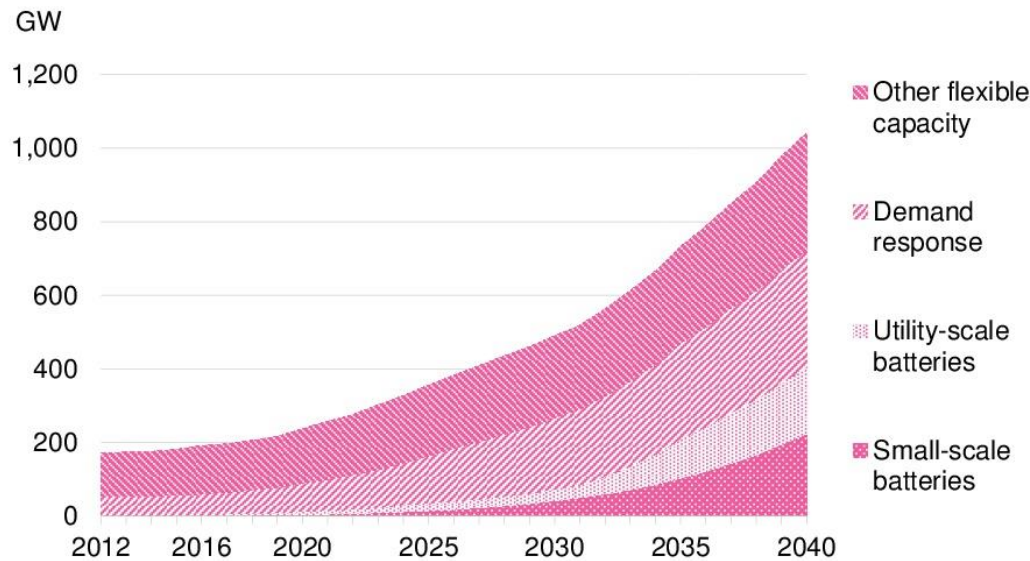
Source: Bloomberg New Energy Finance, NEO 2017

Investment, by technology, 2017-2040

(\$ trillion - 2016 real)



Demand response and batteries meet peak and balance the grid



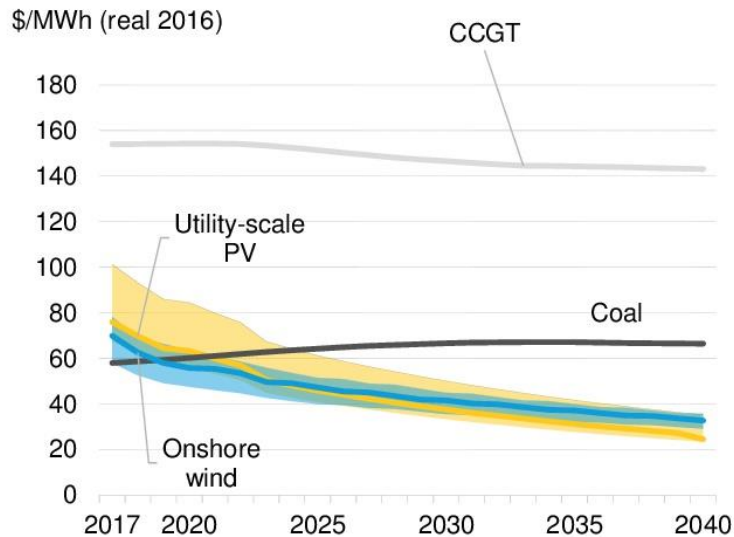
Source: Bloomberg New Energy Finance



Top 5 markets in 2040	
China	343GW
U.S.	200GW
India	127GW
Japan	62GW
Germany	30GW

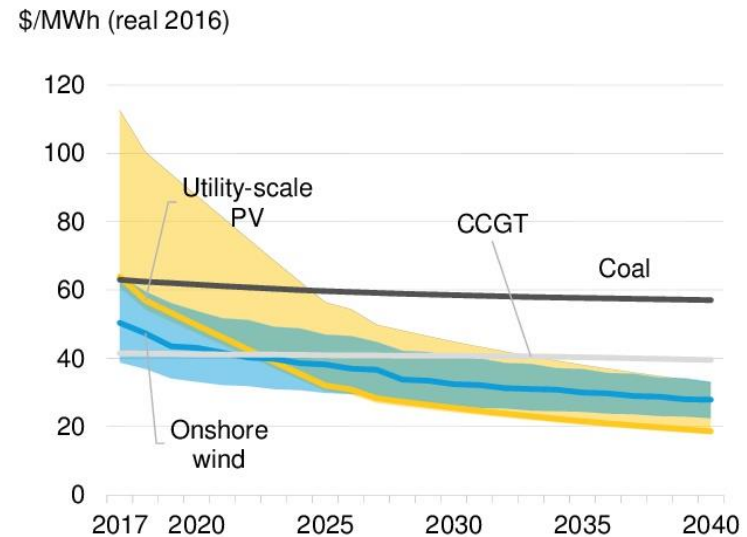
Tipping point 1: new vs new

China



Source: Bloomberg New Energy Finance, *NEO 2017*

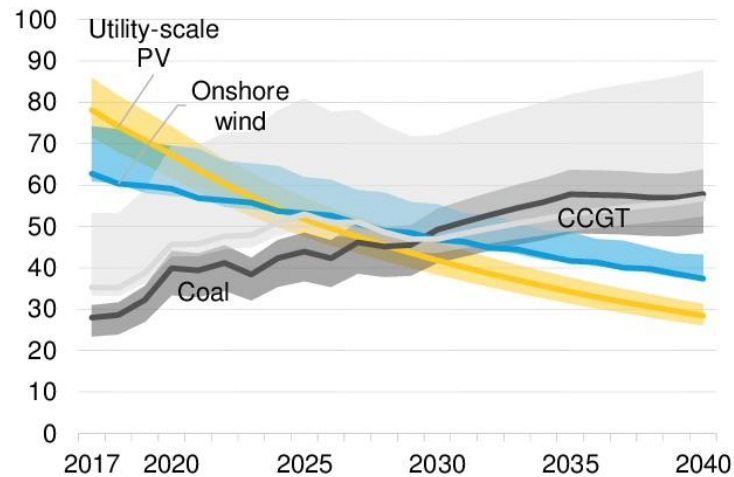
U.S.



Tipping point 2: new vs existing

Germany

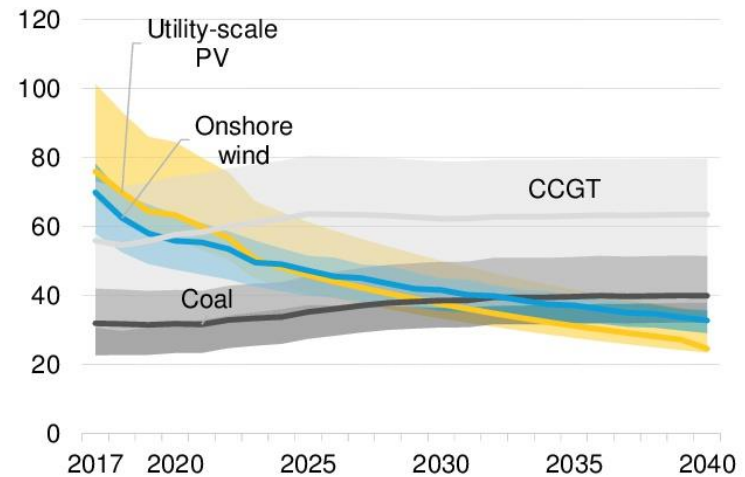
\$/MWh (real 2016)



Source: Bloomberg New Energy Finance, NEO 2017

China

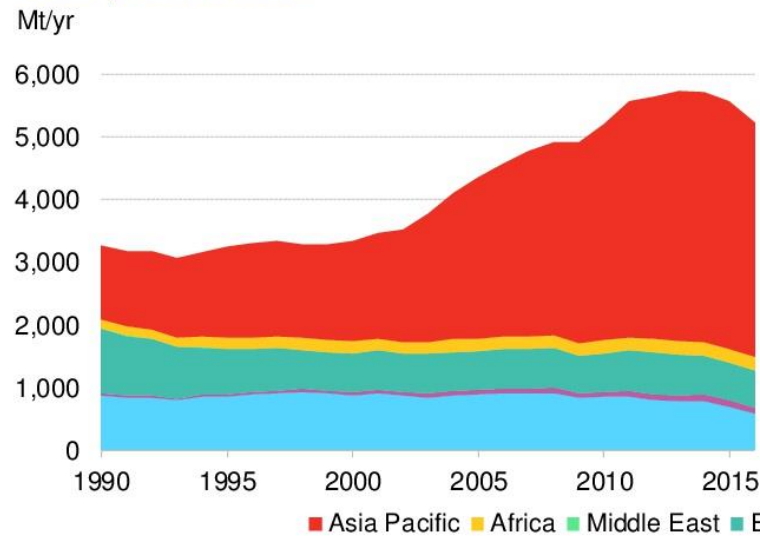
\$/MWh (real 2016)



Coal has peaked

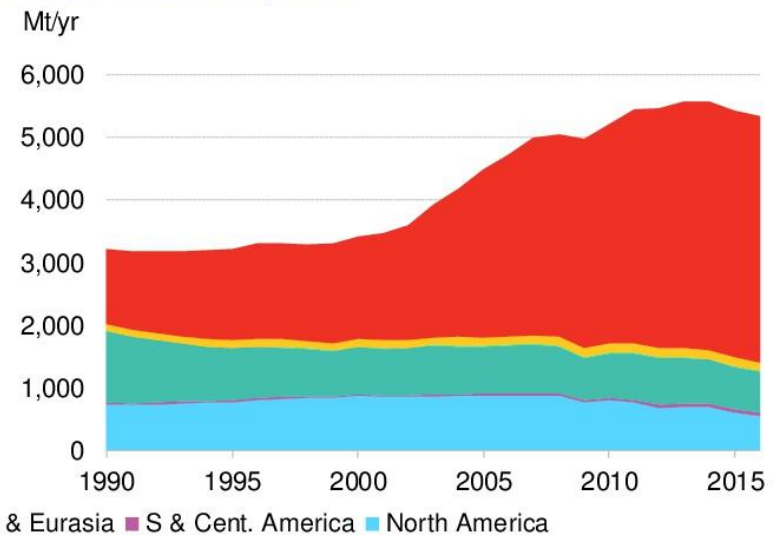


Coal production



Note: Adjusted to standard coal equivalent

Coal consumption



Source: Bloomberg New Energy Finance, BP Statistical Review

Do we still need Airborne Wind Energy



The big challenge

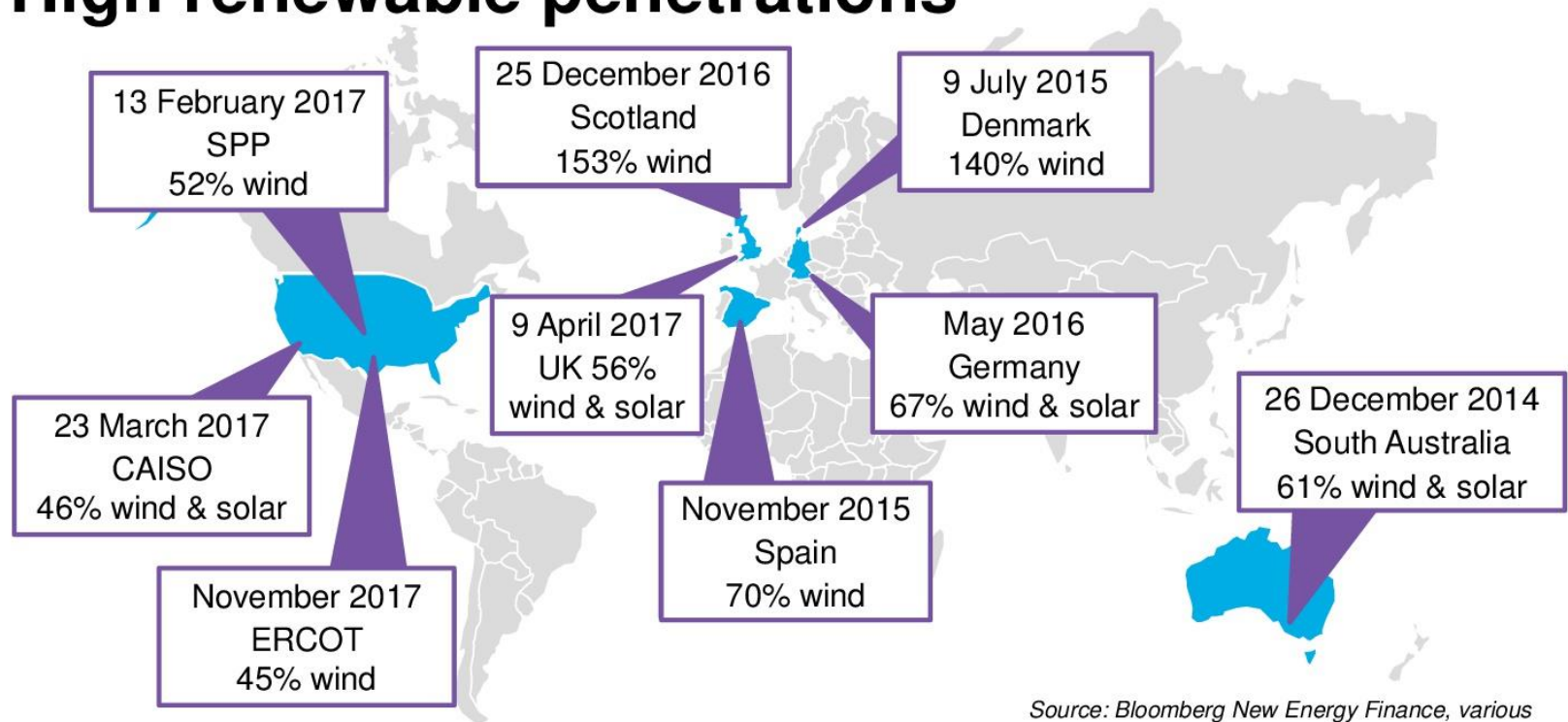


Image: NASA

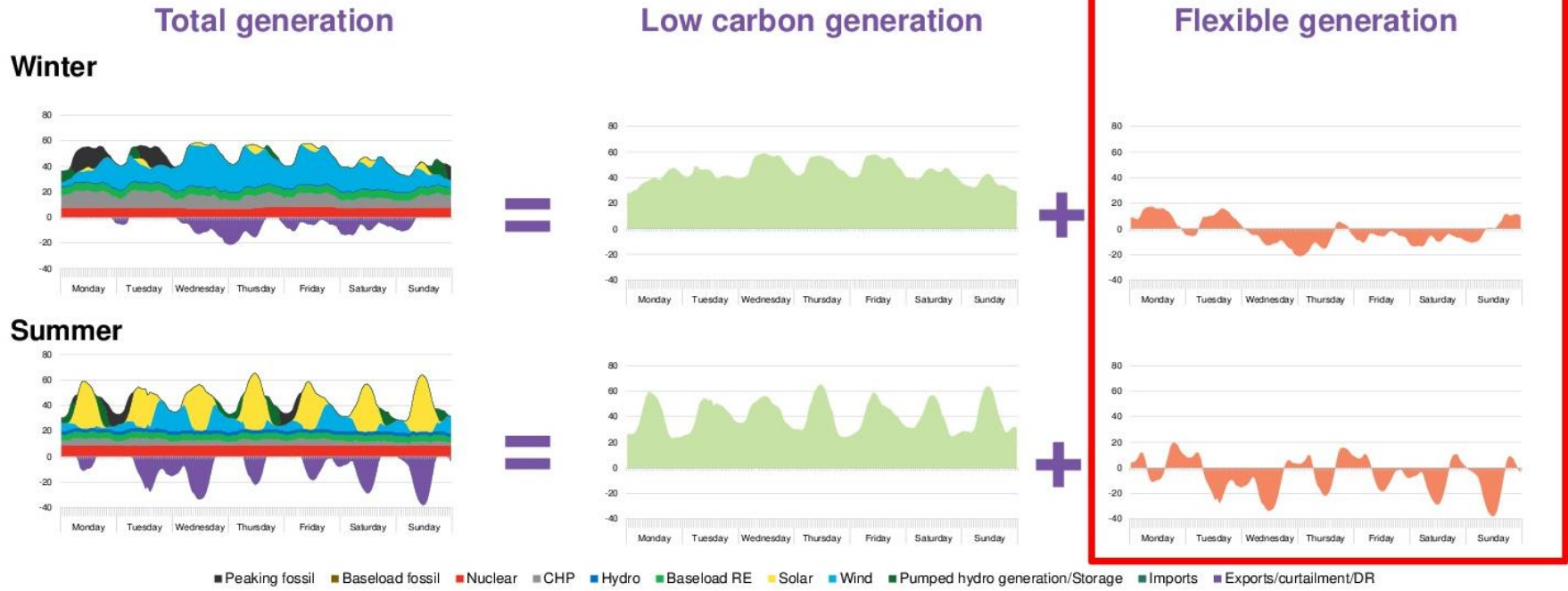
162 September 19, 2017

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High renewable penetrations



Source: Bloomberg New Energy Finance, various



Source: Bloomberg New Energy Finance

New orthodoxy

By 2040...



1/3 of electricity will be wind and solar



1/3 of cars and light trucks will be electric



The global economy will be 1/3 more energy efficient

Source: Bloomberg New Energy Finance, Tesla, Wallpaper Mania, Cleantechnica

167 September 19, 2017

...too hard

Shipping/air/freight



Land-use/deforestation



Petrochemicals



Industry



Energy access

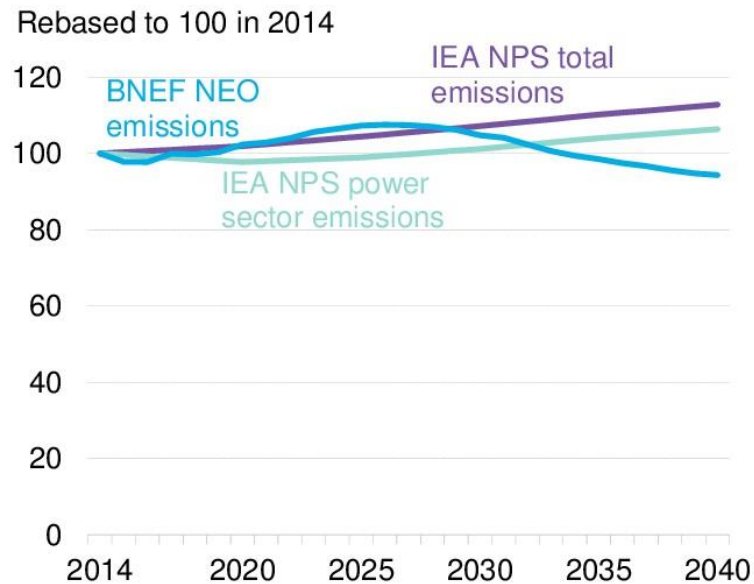


Heat



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New orthodoxy



Source: Bloomberg New Energy Finance, IEA

168 September 19, 2017

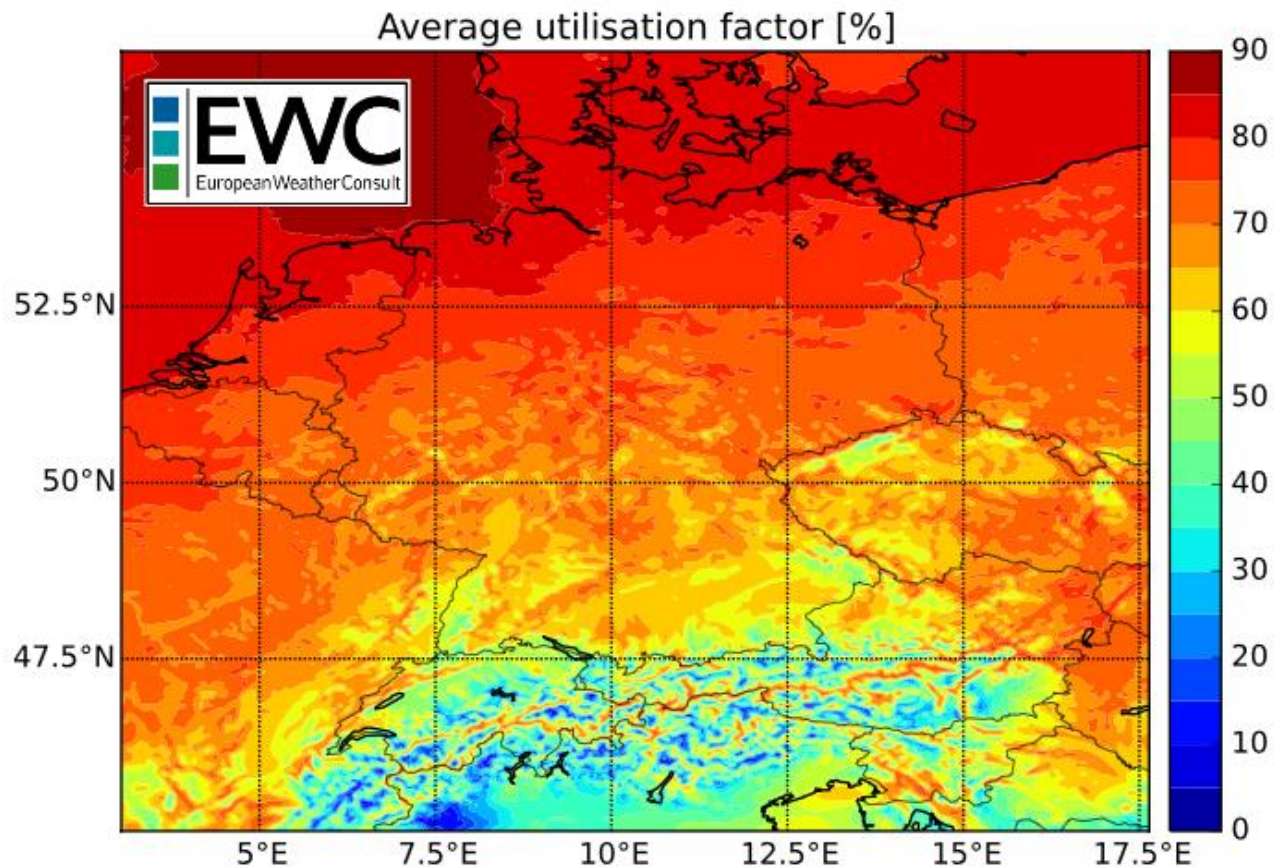
Prove
it
wrong!

Bloomberg
New Energy Finance

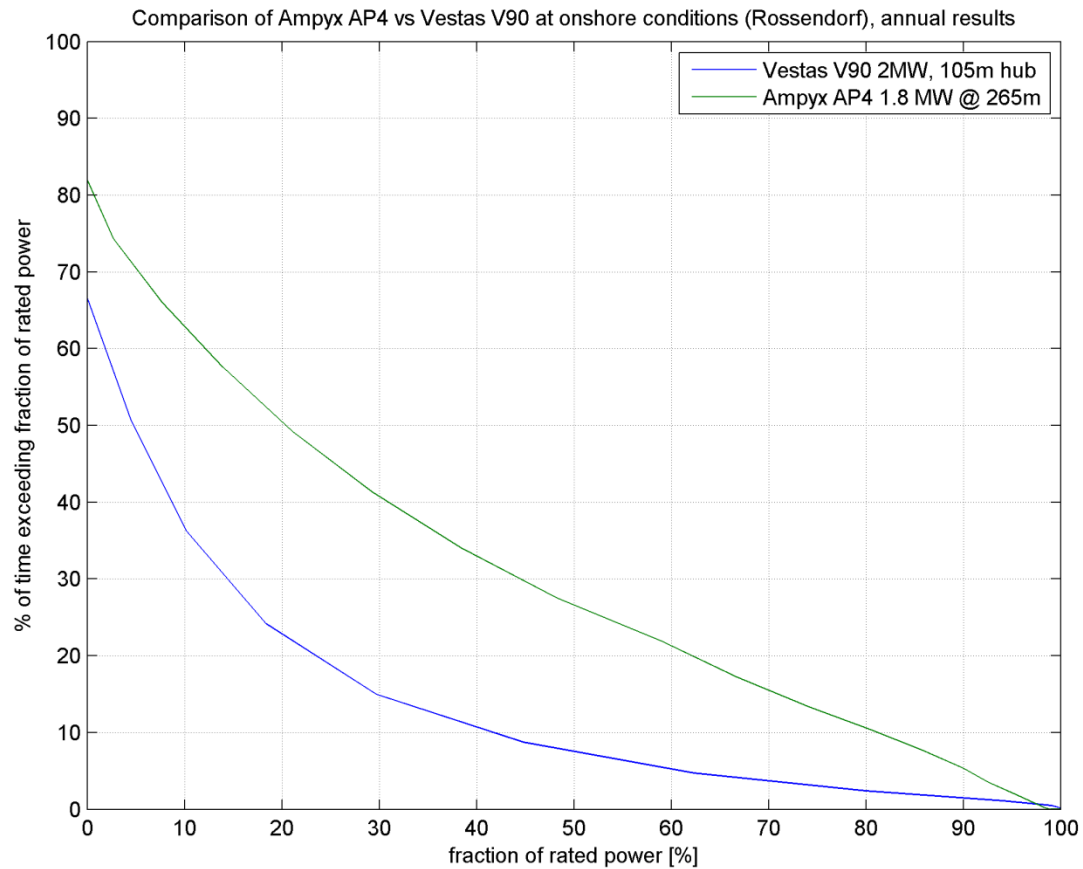
Today's Problems:

- **Non-reliable, fluctuating generation
(What happens when the sun does not shine and the wind does not blow?)**
- **Requires expensive storage and grid enhancement**
- **Still limits renewable % of electricity in the grid**
- **Current technologies not enough to meet climate goals
(Due to fluctuation and not due to price)**

Can AWE be the solution? High Capacity Factor



High Capacity Factor



How Airborne Wind Energy is a solution for today's problems

Lower Storag / Grid Costs

High Capacity Factor

Higher total renewable %

Rugged Terrain

What can AWE offer?

Low Wind Sites

That solves the Problems of
2020 - 2040?

Floating Offshore

Cheap(er) Energy?

Ship Propulsion

Yes, we do still need Airborne Wind Energy



Airborne Wind Europe: Helping the AWE industry to overcome its common challenges

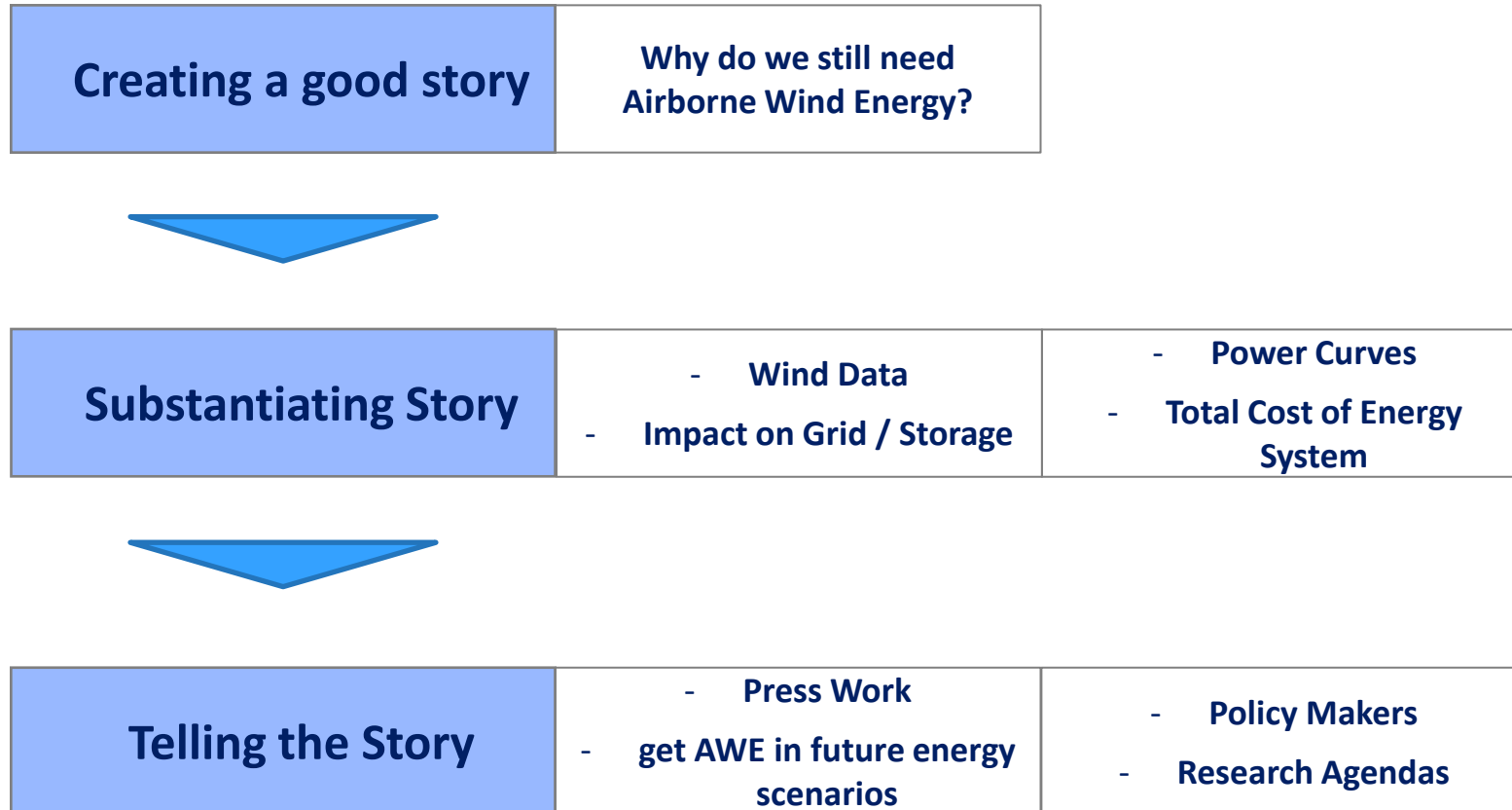


Financing

Regulatory

Technical Challenges

Financing – Storytelling



Airborne Wind Europe: Cooperation of all players



AWE OEMs

Utilities

Suppliers

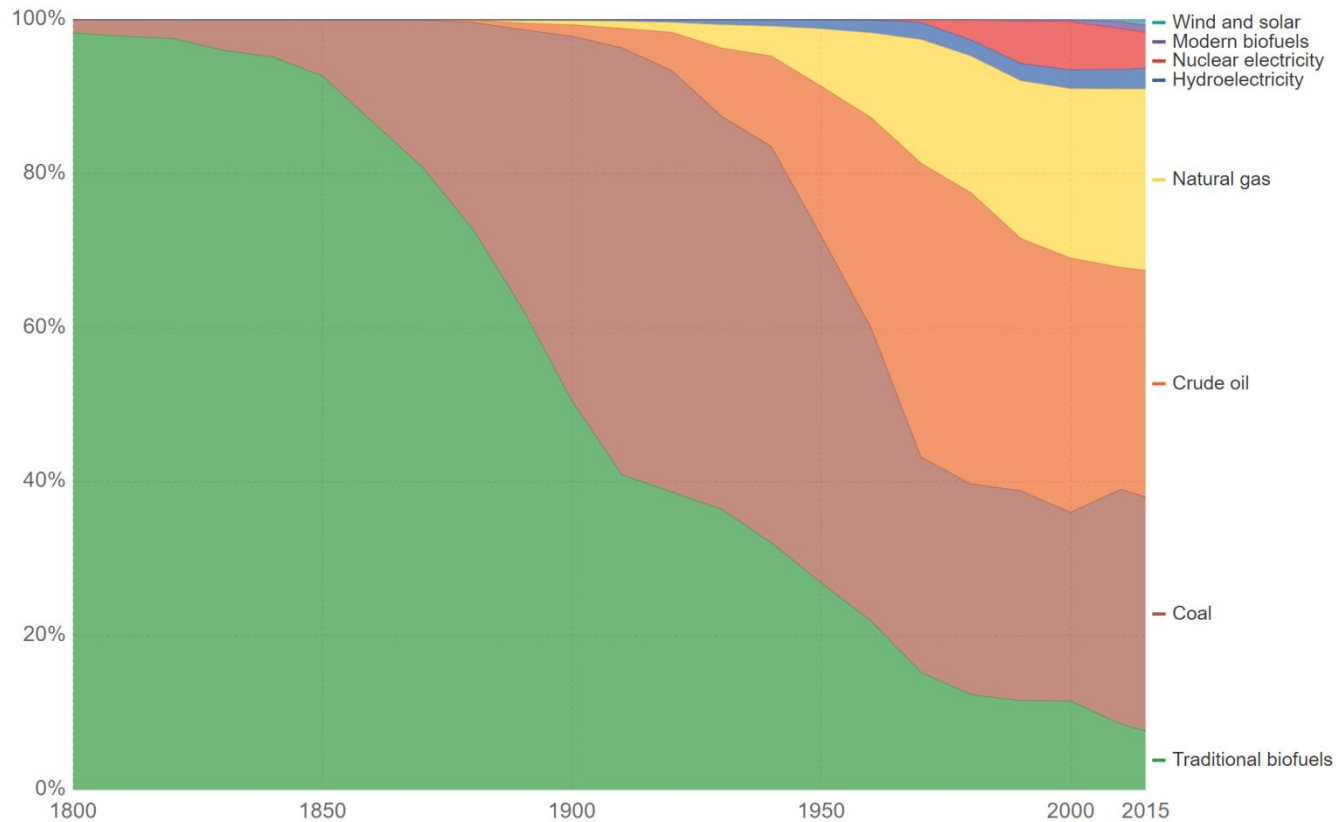
Universities

The world is not already saved

We do need Airborne Wind Energy!

Global primary energy consumption, 1800-2015

Global primary energy consumption by source, measured in terrawatt-hours (TWh).



Source: Vaclav Smil (2017), Energy Transitions: Global and National Perspectives

OurWorldInData.org/energy-production-and-changing-energy-sources/ • CC BY-SA